An automated security response robot

ROBART III (see figure 1) is an advanced demonstration platform for non-lethal response, extending the concepts of reflexive teleoperation into the realm of coordinated weapons control (i.e., sensor-aided control of mobility, camera, and weapon functions).

Navigation

Existing mobile robots typically require a preconceived and very detailed map (world model) of their intended operating environment for path planning and collision avoidance, but most urban warfare scenarios preclude the availability of such a priori information. While teleoperated control concepts support limited remote operation of tactical mobile robots in unexplored urban environments, there is the additional burden of keeping track of the robot's position and orientation. Consequently, it is quite easy to get lost somewhere inside an unfamiliar building and be unable to move about in a meaningful fashion, or perhaps even exit back to the street. ROBART III specifically addresses this need by integrating the applicable features of reflexive teleoperated control and autonomous control. The result is a supervised autonomous system that can quickly explore an unknown operating area with very limited human supervision, generating, in the process, a world model representation that supports increasing autonomy.

For increased versatility as an automated response vehicle, the prototype ROBART III has been mechanically and electronically equipped to support supervised autonomous operation in previously unexplored interior structures. A "human-centered mapping" strategy has been developed to ensure valid first-time interpretation of navigational landmarks as the robot builds its world model. The accuracy of the robot's real-time position estimation (and ultimately the model representation) is enhanced by an algorithm that exploits the fact that the majority of man-made structures are characterized by (but not limited to) parallel and orthogonal walls.[1]

For example, a mathematical line-fit analysis is typically used to detect the presence of a suitable wall-like structure that can be used as a navigational reference. With minimal operator input, the robot doesn't just think it sees a wall, it knows it sees a wall. The end result of such an approach is a much faster and more accurate generation of object representations (relative to conventional sensor-only data collections). This is particularly valuable when there is no *a priori* information available to the system (see figure 2). Under this scheme, the operator, upon first entering a building, would guide the robot by instructing it using commands like: (1) "follow the wall on your left" or (2) "enter the next doorway on the right." Such high-level direction is provided by clicking on screen icons, or by using an optional voice recognition scheme.

Figure 1. Intended to demonstrate the utility of an intelligent teleoperated security response vehicle, ROBART III is equipped with a laser-signed six barrel Gatling-gun and video tracking.

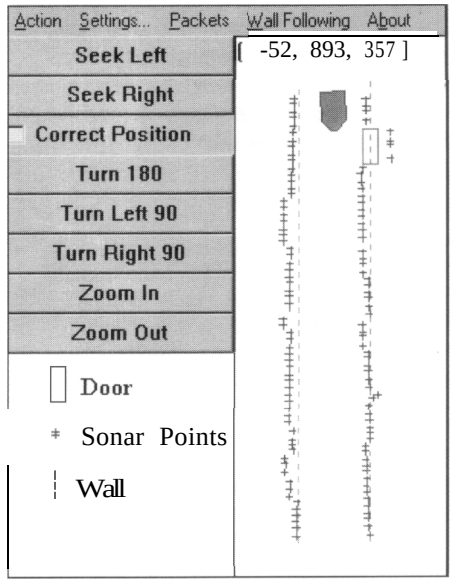

Figure 2. Robot run with actual ultrasonic data, shown during wall mapping of a hallway

Threat detection and response

Extremely robust intruder detection and assessment capabilities, with minimal nuisance alarms, are achieved through intelligent fusion of a multitude of inputs from various onboard motion sensors. Initial detection is accomplished by a 360^0 array of passive-infrared (PIR) motion detectors, which subsequently redirects additional head-mounted sensors (i.e., sonar, microwave, video) to the center of any alarmed zone. The robot pivots in place as required for unlimited (i.e., > 360^0) pan coverage. Automatic camera tracking of a moving target is accomplished using a video line digitizer. This unit grabs three lines of video and subtracts successive lines, returning a pixel number that indicates the center of motion. In a typical situation, ROBART III would enter a room checking for motion with the PIR sensors. Then the robot would turn to face the detected intruder and verify that there is motion with the camera's "virtual motion detector". ROBART III could then train the weapon on the center of motion until an operator dictates what action to take.

Non-lethal response

The non-lethal response systems incorporated on ROBART III include a six barreled pneumatically-powered Gatling-gun capable of firing a variety of 3/16-inch diameter projectiles. Munitions include simulated tranquilizer darts constructed from sharpened 20-gauge spring steel and plastic bullets manufactured from Teflon or Delrin. An optional BB-firing auto cannon is under development to provide a higher rate of sustained automatic fire for intruder deterrent. A visible-red laser sight facilitates manual operation of either weapon using video relayed to the operator from the robot's head-mounted surveillance camera. High-powered strobe lights and three ear-piercing 103-decibel sirens can be activated to temporarily confuse and disorient a confirmed intruder while simultaneously alerting friendly forces nearby.

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Reference

1 H R Everett, ***Breaking down the Barriers,*** Unmanned Vehicles, pp 18-20, February 1998.